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Page

Loc. 82 - Bieber Ranch - Loc. 83 W. of Bullhead ---- 1
Loc 84 - Butte in type Bullhead area ---------- 2
* Loc. ~~60~~ 215 A. Reich Ranch - spur betw. 60 & 61 ---- 3
Loc. 48. Hump Cr. ---------- 5
Loc. 85, 85A, 86 Little Eagle NW quad ---------- 6
* Loc. 56. St. Pats - Bullhead sections ---------- 7
ALSO Loc. 212 sec. B on p. 10 ---------- 10
Loc. 87. Green grass area Lantry NE quad ---------- 13
* Loc. 88. " " " , Timber Lake sections ---- 14
Loc. 89 " " " ---------- 20
* Loc. 90 " " " T.L. Sections ---------- 21
Loc. 91 N. Iron Lightening - general (see below) --- 24
* Loc. 92 Beaver Trap Cr. area - T.L. section ---------- 25
* Loc. 93. E. Beaver Trap Cr. bluffs - T.L. to Colgate ---- 28
74, 82 North Dakota trip with Tove B., Holland students --- 32
285
Loc. 94 - Loc. 95 - general ---------- 37 33
* Loc. 96 - Freeman Ranch - Bullhead-Colgate ---------- 38
Loc. 97 - "Mud Butte" N. Freeman Ranch ---------- 41
* Loc. 98 - Rattlesnake Butte, Grebach Co. ---------- 42
Loc. 75 - General (near me. Hell Cr.) ---------- 44
* Loc. 40 - Westernmost Moreau section ---------- 45
* Loc. 91 - N. Iron Lightening section ---------- 47
Loc. 92 - Note on Beaver Trap Cr. section ---------- 52
* Loc. ~~128~~ - Supplementary St. Pats River section --- 53
* Loc. 56 (212) Section at top T.L. ---------- 55
Loc. 99 - Maxon Ranch - (see Izus notes) ---------- 56
* Loc. 100 - Moreau bluffs just W Irish Cr. ---------- 57
Trip with Wayne Pettyjohn in Stoneville facies ---- 60
Butte cap survey ---------- 62
Loc. 123, 124, 125, 126, 127

Loc 288 ———— p. 33
(A-1409)

KARL M. WAAGE
Peabody Museum
New Haven, Conn.

Credits – 1 piece d'ameublement for Elga Wasserman by

Locality 82, Bieber Ranch.

West-facing cut bank in slump block of Trail City. Concretions in stream bottom. IN NE corner SW 1/4, SE 1/4, sec. 30, T. 19 N., R. 27 E, Little Eagle SE quad., Corson Co., S. Dak.

Cobbens section, taken here in early 40's is just about completely grassed over and only concretions in stream bed attest to highly fossiliferous Trail City.

Found Limopsis, gervillia, Upper Dinic and Protocardia. Some good Upper Dinic were collected.

Timber Lake is in here but no really adequate exposures.

Locality 83, Road cut west of Bullhead

Cut on east side of county road, between Bullhead and Rt 65, near top of hill NW of Bullhead in center W 1/2, SE 1/4, SE 1/4 sec. 14, T. 21 N., R. 24 E, Bullhead quad., Corson Co. So. Dak.

Fossiliferous bank of Timber Lake sand with some "banded bed" lithology in upper half. Exposure is suggestive of interfingering of these two lithologies (see Steves remarks on State Bullhead geologic map). Shale beds fissile & locally fairly carbonaceous. Fauna chiefly Tancredia, Dosiniopsis, small ostrea, Lunatia, P. Inquiformis - but

also a variety of others. Oysters commonly clustered, fair number of Tancredia with two valves - also Dosinopsis. One of few localities where P. linguiformis + P. nebrascensis loose in sand. Shark + other teeth, fish parts, crustacean parts and other stuff. Ian has good data on this locality.

Locality 84, Butte in area type Bullhead

Butte on east side of Bullhead-Walker road in center E½, NW¼, NE¼, sec 11, T 21 N, R 24 E, Bullhead quad, Corson Co, So. Dak.

Bullhead member capped by oyster bed in sand. This is in type area designated by Stevenson. Shows sandy braided beds in fair exposure, mantled by slough from oyster bed. In road gutter some shells in sand and an otolith on crop. Oyster-bearing sand has these in place with both valves and also layers of shell debris. Whether this is sandy bed in Bullhead or is Colgate is not evident.

Loc = 215 Locality 215

Locality ~~60-A~~ Reich Ranch, spur between Locality 60 and Loc. 61. In

Measuring up from toe of spur.

①	5.0+	Shale, dk gray to blk, weaths flaky, finely silty, brn stain on fracture surfaces, typical Elk Butte lithology. Base in slump
②	5.5±	Shale as in ① with concretions top and base + poss. in some scat between. Concs large, weath Fe brn + purplish br, break to blocky frags, limestone.
	1.4	
③	13.9	Shale as in ①, lense layer (creep?) of Fe brn ls concs about 3+ above base.
④	2.4	Clayey silt, blocky, dk gray to gray, calc. conc. layer in base — red to red brn / yellow stained. At top - bentonitic clay layer with scattered cone in cone masses.
⑤	9.5	Clayey to shaley silt + silty sh, gray/dk gy, weaths brnish with appearance of layering. 6.3 from base to top. is zone of purple brn to red brn weath ls. concs with lite gray interiors.
⑥	20.5	Interlayered dk gray silty shaly clay and brownish, sc lam. clayey silts scat rb weath concs betw 6 + 9 ft from base. At top, is very persistent zone of large CB + RB concs with some cone in cone jackets.
⑦	13.0	As in ⑥ above but silty layers becoming

dominant. At top is lower resistant Fe brn weathg, to green + purple brn blocky lavas.

15,6 Gross covered slope to top of lower of two large conc layers

15,4 Sandstone under grass slope to top big conc zone with transitions.

Units above ⑥ appear to be in place but part of section is missing; The two upper layers of large concs with Timber Lake fauna in and between are probably 2 slump blocks.

Needs rechecking

Locality 48 – Bluffs south of Hump Creek.

Re-examination of this section shows that the 8-foot layer atop the banded beds is a zone of contorted blocks of "Colgate" in clayey silt, and is a bedding texture not a recent slump. The small pinnacle of banded beds out from the Colgate-Hell Creek scarp has this layer as a "caprock". Even concretionary blocks in it show rolling of laminae. This flow-zone is present throughout the limited area where the banded-bed – Colgate contact is exposed at this locality. Underlying banded beds locally rumpled and scooped out.

Although no other Bullhead member exposures measured to date in this area it is obvious from outcrops N. of Hump Creek + E of So Dak Rt 65, that this section has less of the member than normally present. This may be due to fact that Colgate locally thick here whereas to N. Colgate thin. ~~to~~ The "flow zone" being present with thick Colgate may be significant.

Locality 85, 85A. Small outcrops on shoulders of spurs E and W of main gulley draining SW¼, Sec. 24, T. 20 N, R. 25 E, Little Eagle NW quad, Corson Co., So. Dak. #85 in center W½, SW¼, sec 24. and #85A is on the E½, SW¼, Sec. 24.

Protoceratia and Gervillia-Limopsis can be found approximately in place on spurs. Barren layer above Protoceratia about 10-15' (approx). Above this Timber Lake comes in gradually - bases of soil getting sandier. No trace of Abyssinus layer but dark O.B. zone in sand indicates glauconite zone at approx same level as at locality 30. Collected from Protoceratia only.

Locality 86, Small exposures in lower bluffs either side of draw, due north of Mortensons Ranch, ~~NE~~ draining S along E side NE¼, sec. 33, T 20 N, R. 26 E., Little Eagle NW quad, Corson Co., So. Dak.

One small D. nic. conc. in place and some Limopsis-Big G and Gervillia. All exposures are in small slump blocks on Elk Butte shale.

Loc. 56

St Petrocks butte -

Section A. - (Skeleton for key beds.)

(1)	5.4	Intrabedded BB and grey weathi ss, about 1' ss at base sndy lb zone at top and .5 bed approx 3' from top. Sand lami. plnt trays loc. on bedding.
(2)	4.4	BB's with approx 1.0 of sand + clay ptugs at top. (These sands and those below with small rb weath grey calc cons with bedding)
(3)	7.4	BB's - very few thin ss layers
(4)	3.0	BB intrab. with sand. A few scattered calc. sand bodies in sandy zone at base.
(5)	6.9	BB with very little ss
(6)	3.6.	BB with foot ss at base and some IB ss to base ss conc zone
(7)	3.2	Sand, fine gr. (all preceding is vfg) ss, with large light grey weath conc masses.
(8)	7.7	Intrabedded fg ss, vfg ss + clayey sand. local calc stained layers + CB conc laminae some silty clt sh laminae near top Foot ss at top. (Note calc frag on sand bdg plns)
(9)	12 +	Clay, silty to sndy, loc. shaly, with scat to gross roots. IB. f to vf sand. Weaths to darker grey at base lighter above. Loc. some flat calc. crumbly conc masses at base.

Section B. (See old notes - this is same as base of old St. Pats. section, T36-C, 1954-1, p. 64
Podewell St Pats #3 has better breakdown? The red letters are his samples
Base on layer of OB weath. calc. concs loc. with gray silty jackets. A few fossils — Tellina, P. linguiformis Mactra scattered but locally accumulations of more complete Timber Lake assemblage. (Collection labelled "uppermost TL conc. layer.")

(1) 4.0 Clayey silt and sand, gray, "worm-worked", with scattered small, locally fossiliferous OB weath concs in basal foot. Above this scattered clusters of shell fragments in small subspherical masses, shells loose in matrix, fragmented for most part though gastropods commonly whole. (Coll. B-2) A
Scattered gypsite blebs. Grades to well-bedded unit above. Contact fairly sharp. Mkd by top limit of shell clusters with ostreas (see coll B-2)

(2) 1.2 Banded beds, alternating layers, ± D.1, of waxy finely silty gray clay (locally blebbed) and layers of clayey gray silt. Layer OB weath blebs at base and fairly persistent OB to yellow weath silt layer at top. B

(3) 14.0 ± Banded beds, prob., covered by popcorn crust to top of dark band indicating highly bentonitic layer. C from top

(4) 7.0 Banded beds under popcorn crust, loc. persistent rusty zone at top.

Ammonite (B-3) in float on surface this interval.

(5) 2.6 B.B., grey clayey sandy silt, & silty clay, lower 1.5 obscured by popcorn. Rusty zone at top.

(6) 3.4 Interbedded vfq, sandy clayey silt to vfq snd, x lam., and silty clay, beds <0.1 to >0.5'. D at top

(7) 5.7 Interbedded fq & vfq sand layers & BB's, 1.0 ss at base with local irreg $CaCO_3$ conc, light grey masses., another 1.0 ss starts 3.7 from base, and at top is a third. All have local light colored conc masses. ~~(C of sample A)~~ E at base

8 7.2 Banded beds, with 0.5 vfq ss at top.

(9) 18.0 Banded beds, sand. beds up to 0.4 + at 2.2, 4.5, 11.5 (tops) from base. F G at top

(10) 4.2 Sandstone, vfq, clayey, weath somewhat fluted, x-lam to 1cm loc, with plant frags on bedding surf.; also layers. O.B. conc. flakes. Local $CaCO_3$ white weath, x lam masses in this interval.

(11) 5.2 Sand, as below, with numerous ab small to med (1.0) flat concs and OB stringers. Bed contorted, so are some of the concs, which obviously were plastic at time

of deformation. This deformed zone varies in thickness here, locally expanding into unit ⑩ below
H just above top mtes.
East end St. Patricks exposures -

N 26° E, 9° NW at base bluff near road, east side. Steeper dip appears to be in this area.

First butte SE of rd up bluff - Coll. from base SS channel near top, about 17' above the key ss. conics. For 6' ± above the key ss cones is contorted zone then banded zone to base Fig channel sand.

Loc. 212, Section B
~~Section C~~ begins on wash slope at base of popcorn with obvious though obscure bedding. Mud butte in center W½ SW¼ NE¼ Sec. 26 T. 15 N R 21 E

① 5.+ Popcorn slope, fg st. mud band about 2.0 from top. At top Sect small, rounded gray-weath cones.

② 4.4 Popcorn slope, stepping in upper foot.

③ 3.5 B.B. with sand layers up to 0.4. One of heavier at base. At top sandy zone with local cone masses, small to 2' long.

④ 5.8' BB., popcorn crust, slt. silty cl + fine clayey s.l + sand.

(5) 3.2 — BB with 1 b. sands about 0.5 ± at top + base with thinner ones scat. between. Lower ones are stained crumbly, upper weath white have small rb weath cones.

(6) 3.3. — As in unit 5 with 0.5 bed ± at top.

(7) 8.7 — As in unit 5 with more numerous ss layers in lower 4.7, more clayey in upper 4.

(8) 4.2 — Clayey to sandy silt, sandy layer 0.5 at base. Bdding obscure, is chiefly massive with contorted sandy blobs up to 2.5 diam scat mostly in middle part. Locally the batter sandy layer is crumpled.

(9) 2.8 ± — Banded beds with sand at top about 0.8, local sand cones.; Much plant material, lcc. purple sandy beds due to lig laminae.

(10) 6.8 — B.B. with three ss beds ± 0.3 at 1.0, 2.5, 4.6 and an 0.4 at top.

(11) 6.0 — BB., several sand layers in basal foot and mid slope.

(12) 14.6 — Sand, vfq, clayey, to fq lite gray weath. 5.0 to top layered calc. cones, above this vague contorted zone with scat large (4.0 diam.) calc. cones. Sand is X bedded + X lam. Top of this unit X beds are truncated.

(13) 6.7 Alternating beds of fg s and slty sand beds up to 1.5 thick, distinctive unit of fine (relatively) beds.

(14) 18.0 to ? Sand. fg., channel type x bed x lam. in upper 8.0 zone, huge bru weath cones, of x lam ss. Loc. with interference ripples.
This sand sone is one on 1st butte SE rd. that has small coll incl. wood, pavement tooth, rapt. tooth & shks tooth.
butte top.

Locality 87 - Road cut and hill slopes in SE corner Sec. 27, T. 14N., R. 23 E, and adjacent SW cor. Sec. 26, Lantry NE quad., Dewey Co. So. Dak

Concretion layers in Timber Lake and top of Trail City, but no exposures offering very good section.

Timber Lake member exposed at edge of bluff. A vfg clayey sand. Not good enough exposure for adequate section.

CAZ — Large concs barren or nest of small Idonearcas.

A 740 — "Barren" layer, brn clayey ls concs OB weath – Loc. fos. as mentioned

Red brown weath. concs, jacketed, bearing big spheres, some big *D. nebrascensis*

Three prominent conc. layers as shown above, but many loss. concs scattered – or not located in interval between Big sphere layer and top layer. Also some in float above top layer in grass but may be gravel.

Note – Rod Feldmann found a "nebrascensis" only about 3¼" long, mature but not so many scales on tip BC. Borrow if needed.

Locality 88. Exposures on NW facing bluff and spurs below it in the E½, NE¼, sec. 27, T. 14 N., R. 23 E, Lantry NE quad., Dewey Co., So. Dak. Sections on spurs, including one extending NE ward into NW corner sec. 26. Elk Butte shale to the small Iduncerez layer in Timber Lake member

Section 1. Beginning in gulley side where there are no markers and apparent transition from Elk Butte to Trail City

Base slope

① 6.3 Intermixed dk finely silty shale and clayey silt shale like that in Elk Butte but silt pods like T.C. shale locally, most common fracture fresh is blocky; weathered - shale predominates

② 0.3 Gray silt layer, loc. shaly silt, slightly clayey

③ 9.0 Blocky clayey silt, gray, and darker gray as clay increases, some silty shale but this chiefly in lower part. At top scattered gray to red brn weath. silty punky calc concs. 1 or. with cond in cone outer layer. May not be a continuous layer. Cores are X bm silt + appear local conc. in a fairly continuous silt layer. Trench shows silty layers irreg, silt with clayey at top but chiefly mixture

(Zone 0.4 thick)

④ 5.7 Clayey silt gray + dk silty clay, blocky irreg mixture. Silty band 0.3± at top locally Fe stained and some calc concretionary bodies with 0B to RB staining. Small rounded gray is conc

with OB rind (1/4") about 0.6 from top, max diam 0.6.

⑤ 4.6 — Upper 1.6 grassed remainder as in ④ below.

⑥ 12.5± — Covered - to top Limopsis conc layer which chiefly between is concs weath. OB. But one cluster Limopsis + scatt. long hinged clam found loc.

This may include slump + repetition

Offset to Ⓐ slope, above head gully. Ⓑ next base slope W.

A 10.6 — Top Limopsis to top Protocardia layer

B 11.8' — " " " " " "

Offset + — Possibly top calc concs top of interval ④ above to Limopsis 10.5 ±., but not sure base is same.

Section 2

Protocardia layer - measuring up from top

① 8.3 — Silt, minor vfg snd, weathers yellowish gray, with ptngs gray silty shale. Local silt beds some OB to 1 cross. rc stains.

② 10.7 — Gray silty shale, fissile at base where in sharp contact with yellow silt below. Sharp color change on weathered outcrop. Upper 0.5

covered to top where barren is conc. zone. This is widespread barren zone. Locally conglo brittle lt. weath brown, rusty. Numerous + continued to about 1 foot; vertical.

③ 3.0 DK Gray silty sh some clayey silt mostly weath. or covered interval.

④ 0.3 or less Silty bentonitic clay lite gray to greenish gray. (Local conc-in-cone concretions about 1.0 above)

⑤ 2.0 – ? Shale as in ③ to gravel or slopewash cap. About 1.0 to 1.5 above bentonite locally popcorn crust with scat conc-in-cone concs.

Section 3. Skeleton up spur of hill.

Beginning on top barren layer above protoceratid.

① 27.6 Covered except for lower 5.0 which is brush gray, silty shale with thin bentonitic layers & concretions 2.5 ± above base.

At 14 to 15.5 ± layer scat. barren red brn weath. concs.

At top is persistent jarosite with

cumbly lite grey silt comes loc. + same conc in conc. Another row jarosite blebs 1.5 to 2.0 below it.

(2) 4.0 Clayey silt + v.f.g. snd weaths lite grey jarositic blebs in crude layer about 0.2, others scattered. At top layer red loam loc. jarcreted concs brown.

(3) 14.0 Up old road, chiefly covered on upside but lite grey weath. clayey sndy silt + v.f.g. snd.
Layer of Is concs-brown at 5.5 from base. At top in upper 1.5 to 2.0 is Big Sphaeno conc layer.

(4) 17.3 Top Big Sphaeno to top "barren"

(5) 8.0 Top "barren" to the small Idonearca concs top of plateau.

Section 4 Spurs E into gulley about 12° NW of Sec. 3. Protocardia + Limopsis layers prominent, chiefly unfossiliferous. Beneath the Limopsis layer small concs. equivalent to two ammonoids, secure to be coming out mostly, with, 9 or 10 ft below and 5 ft below but cant be certain.

Sketch for sketch in (cover)

Trapp wash.

(1) 10.0-? Silt, clayey gray, minor silty dk gray clay. Scattered small ovoid concr white rinds, some lite redd. brown "sucrosoid" types and some up to 0.8 in gray jackets.

Ammonoids (loc. 88, sect. 4, lot 1) float, from concs in this layer, chiefly from small white rind type. Weathered conc body chambers common also.

(2) 1.0 ± "Liriopsis" layer, here unfossilif. Is concs weather rusty brn with calc calcite in druzies loc.

(3) 11.0 Chalky silty gray to dk gray shale & shaly silt with brown stain, fe, float is most noticeable in lower 5' ± as weath crops. Scattering of small concs near top but distinct not clear line of this zone. Ammonoids appear scarce with small concs (some in light in earth conc layer above (

(4) 1.0+ Conc layer, chalky, waxy, gray to pinkish brn weath concs. Irreg oval compressed & bedding ? Positive relief. Scarce fossils except rare loc. in the big concs also in small concs. Fish ? plates to 2" among them. (Loc. sec 4, lot 2 In big concs are chiefly Inoceramus & ammonoids.

Loc. 88 (cont.) Miscellaneous notes.

A-1386 About 3.5 to 4.5 ± feet below the big sphono layer are scattered smaller hard ls. cones also weath red brown, many are highly fossiliferous and contain mzudzuensis – the very small scaphite and numerous juveniles. Sampled several.

Locality 89 Exposures on spurs and slump blocks NE of bluffs on T.L. member in SE¼, SW¼, sec. 22, T. 14 N., R. 23 E., Lantry NE quad, So. Dak.

Scouted without success for adequate section across Trail City lower contact but too much slough. Potentially good from Elk Butte to Protocardia but would take deep trenching

On lower spurs below the large T.L. slump block Protocardia and Limopsis layer present. Probe yielded a few scattered D. nicolletti's and Limop layer, one small Sphenia and a single Limopsis. Hence a Limopsis zone of small, abundant cones many of which contain D. nicolletti and larger ammonite, one had numerous Drepanochilus (collected). The contact with the Elk Butte is nowhere adequately exposed for measurement, it seems that the thickness between Limopsis layer & Elk Butte is greater than usual here, at 68 and probably also at 30,

The large Timber Lake slump here has its face sloughed badly - needs more slipping to afford a decent section - very poor at moment. It has slid over upper Trail City.

No good exposures here for measuring, but may be fair collecting - particularly at upper conc. layer — Idonearca carbon & white ones.

Locality 90 Surfacing exposures on ridge, chiefly in NE¼, SE¼, SE¼, sec. 21, T. 14 N., R. 23 E., Lantry NE, quad, Dewey Co, So. Dak. Good exposures from somewhat below Big Sphaus layer to small Ideoceras layer. Excellent collecting in T.L. - especially small Ideoceras layers.

Section #1

Beginning on top conc. layer that is apparently the barren one above the Protocycelle layer.

		Conc. layer
①	1.0	Dark gray silty shale, mostly covered
②	1.0	Bentonite, olive green, silty.
③	13.5	Gray silty shale becoming blocky upward, weathers to brownish gray checked surface. At top is zone scattered reddish weath. is concs with golden calcite 1.0 to 2.0 in diam. Few fossils Nerinea, Sphenodiscus frag.
④	14.8	Interbedded gray clayey silt and dark gray silty shales, former predominates, latter in thin partings. Weathers to light brownish gray checked surface in contrast with darker brownish gray weathered surface of lower 10 ft of unit ③. One small red weath. conc. (1 x 3" long) about 3' from base.
⑤	2.8	Gray to dk gray clayey silt with irreg silt blotches and 0.1 to 0.3 layers of dense silt at base, top and 1.0 from top. Concretions consisting mostly

of crumbly gray silty jacketz occur locally in loess like layers.

(6) 17.0 Lower 5.0-6.0± chiefly dk gray clayey silt locally shaley. Above gray to yellowish or light brownish gray sandy, clayey silt, sand vfg increasing upward as clay content decreases upward. At 9.0-9.5 ± scattered red weath is concs. and at top is Big spheno conc. layer. Both conc layers loc. jacketed. Big spheno layer

(7) 5.7 As in 6 below to base layer scattered large conc masses vfg sand & silt that weath platy to flaky gray to brn. Some of these concs is white sand from preceding interval.

Section 2. On toe of SW trending spur to ridge

Beginning at top of big spheno layer.

(1) 5.2 Gray to yellowish gray vfg sandy silt with some clay and blebs dk silty silt weaths light yellowish gray.

(2) 9.3 Intermixed, mottled gray to yellowish gray vfg sandy silt and gray silty clay. Which is clay richer, less sandy than interval (1). At 5.3-5.5 and in top 0.2 are OB stained. Zones with thin silt & vfg sand.

(3)	7.3	As in 2 below with clayey silt decreasing gradually upward. Locally some crudely conc masses lite gray weath sndy silt about 1.3 from top. Upper 2.0± is chiefly the yell. gray sndy silt with minor amount of dark clay.
(4)	2.0	Sandy silt and vfq snd, minor clayey blebs. At top zone between ovoid concs of brittle ls, usually with long axis that is ⊥ bedding. (This is "between" zone of Local Nos 88 + 87)
(5)	9.8	Sand, vfq, silty, weaths yellowish gray local OB splotches, whitened fos concs in upper 2.0 to 3.0.
(6)	1.0 to 1.5	Sand with concs. up to 1.5 thick and 4.0+ in long axis, many large ones with some Idocrase, weath brn-gray to brn. Also in and just below this layer are lighter "white rock" concs in very few fossils.
(7)	2.0+?	Same as below to grass roots.

Locality 91. Large area badland type exposures from somewhat below banded beds into Hell Creek, in W and SW facing bluffs east of Moreau River in W 1/2, Sec. 9, T. 14 N., R. 19 E., Redelm NE quad., Ziebach Co., So. Dak.

Access to this locality can be had from south, coming in on trail above bluffs E of Iron Lightening and follow it on down to lower terrace in bend of river west of locality bluffs - then walking across the Moreau. Bluffs show complete banded bed section although base is in question as contact nowhere clear cut. No Timber Lake fossils were found but concentration of brittle is do occur below banded beds. In a Trail-City-type limonite. At or near contact is a bentonitic or bentonitic clay.

Colgate-like lense in about 2/3 up in banded beds, and another at top which channels into hill a little at the part banded beds. Hell Creek in for 20-30 feet to top of bluff.

Section not as fossiliferous as Iron Lightening. Should be a good check if bottom can be found.

In NE. cor. Sec. 9 - 1st SW gulley in face in this corner, seems best spot for bottom. Here Jarosite layers exposed and can probably get down to upper T.L. bentonite

Locality 92 Exposures on both sides SE trending nose of high bluff, at confluence of Thunder Butte Cr. and Beaver Trap Cr., lying chiefly in NW ¼, NW ¼, SE ¼, sec. 29, T. 15 N., R. 20 E., Thunder Butte quad., Ziebach Co., So. Dak. Extends into W side NE ¼ NW ¼ SE ¼. About 80 ft of lower Fox Hills up to bentonite at top and including remnant 15 feet fossilif. zone of T.L. member.

Section 1. On SW-facing bluff above Thunder Butte Creek

Measuring up from top of bevren ls. conc. layer (local designation layer A). - Locally this conc. bulges up to 2' thick 4' long D., weath yellow white - cuts sandy, silty ls. into ten bright

① 17.5 — Sandy clayey silt with blebs vfg sand + silt, massive, gray with yellow to orange Fe stn. on fresh, weaths light brown q. eq. Arbitrary break this unit to record finds + fossilif. concs found in place = spec. 92 ① a (A 798) (A 797) and 92 ① b (A 799)

(A 920) Spec 92 ① c found 1.0 above the others.

② 14.0 — Sandy, clayey silt as below, somewhat more clayey in lower 8 ft, clayey areas dirt gray Scattered ls cons, some barren, a few fossilif. up to 1.0 from top. Big spher. concs in sandy parts 1.0± from base

(A 921) Spec. 92 ② a 1.5± from top

③ 0.4 — Devositic clayey silt with bright yellow-orange band - 0.1 at top.

④ 0.4 — Bentonite, yellow green, finely silty

⑤ 5.5 → ? — Gray clayey silt weath. brn lower 0.8 bentonitic. Unit is fairly [illegible]

light gray with silt in swirls, less common laminae. About 2.0 feet above discolored zone overlying gravel cap comes in some small burrow-like cones 1.5 and 4.3± from base.

Top of bluff

July 19?

(1) NE¼, SW¼ sec 10, T129N, R81W, Lower Hell Creek pinnacle with Fe conc layer containing gastropods and chams - Steinkerns.

(2) SE¼ SW¼, sec. 26 T134N, R. 80W, on south side Cannonball River, Sioux Co., North Dakota.
Roger found Sphenodiscus in the sandstone which 2150 has Desmophyllo + Turcodia - see our collection. Donated Sphen. to N.D.

Locality 93 Local badlands in bzuded bed on SW face of bluff above valley of Beaver Trap Cr. in about center SW 1/4, Sec 21, T. 15 N., R. 20 E., Thunder Butte quad, Ziebach Co., So. Dak. Face drained by 3-headed gulley in center S 1/2 SW 1/4, where base sections taken

Section 1. Center E 1/2 SE 1/4 SW 1/4 in first NE trending tributary to the SE gulley above confluence of the 3. Measuring from top of bentonite, unit 4, Sec. , Loc 92

(1) 16.8 Dark gray clayey silt with blocky fract, at base grading upward to a gray clay shale very finely silty if at all, with scattered fucoids, good shale beds as thick as 5 ft thick

(2) 2.3 Gray shale some silt laminae, at top and base interlam. vfg sand in zones 0.3 and 0.4 thick, both highly chevroned with jarosite. Shale has fine cuttings as in some bzuded bed above, scat plant fuzzys common.

Section 2. Starts in NW gulley below head and carries NE to base bluff and up just SE highpoint.

Beginning with jarosite zone = (2) of sec. #1 by tracing

1 3.0 Gray clay shale, finely mottled with 0.5 jarositic zone at base and 0.7 at top (dark). Both on vfg sand interbeds.

2) 3.6 Chiefly shale, weathering light brownish gray with scat plant fuzzys and liq. pzt nests, with interbeds of gray silt + some, scattered very sand with concen. jarosite or fe stain. thin interbed in upper 0.6 for most part.

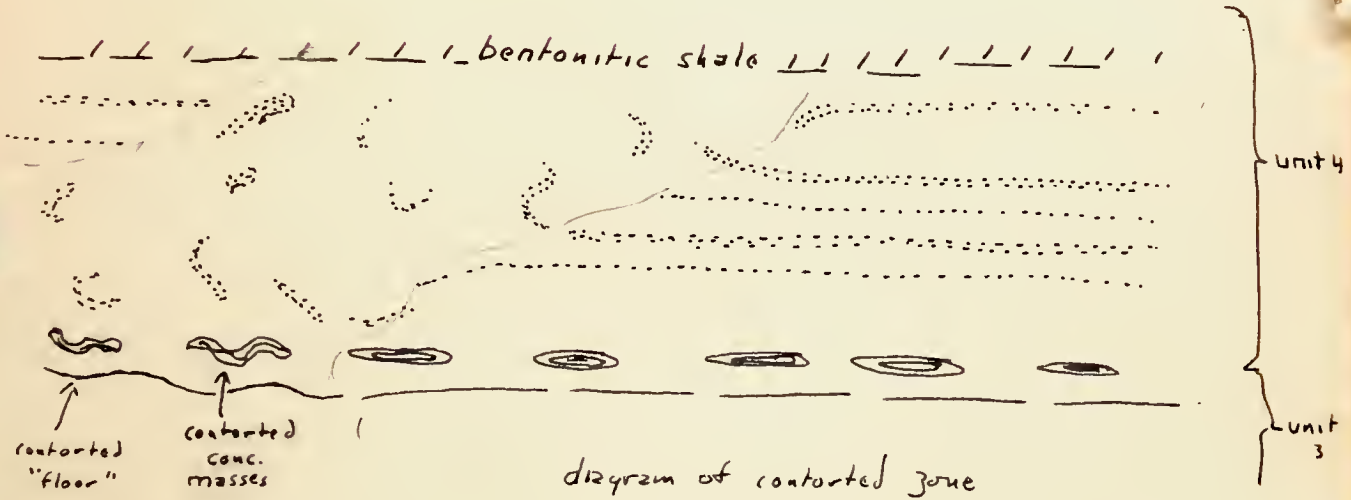


diagram of contorted zone
see kodachrome

③ 5.7

Interbedded grey clay shale (as above) and silt. About 4 prominent silt beds, 0.6 at base, from 3.2-3.7, then 0.4 at top. Each has thin [illegible] with Xlam. Shaly clasts scattered throughout, underlying layers sandy silt to Xlam. Additional siltier layer: silt, 2 above underlying bed. Bottom is muddier layer. This interval most structurally obviously deformed of all. [illegible] throughout

④ 9.0

Thinly interbedded shale, silt + VFg sand similar in litho to unit below but with shale predom + silt rare, exceeding 0.1 and 5 rarely. About 2.0 at top is highly bentonitic shale with [illegible] and local concretions.

Locally lower 8.0 of this unit (under bed) is occupied - mostly by muddy clayey silt with [illegible] small burrows

⑤ 2.1

Interbedded shale + sandy silt as usual but 0.6 bed silt at base and at top which [illegible] exceed 0.4 thick each. Xlam common in lower silt [illegible]. Some clasts in [illegible] + scat. burrows + blebs.

⑥ 10.7

Interbedded clay, silt + sandy [illegible]. Cm [illegible] at top and [illegible] from 2.0 to 5.2 as above with silt beds up to 0.4 and layer of coarse at 5.6 [illegible] Above is [illegible] chiefly shale [illegible] Red mott-brained horizon [illegible] brownish grey, unobserved [illegible] lower 5ft grey, brownish [illegible] silt [illegible]

At top is rb conc layer clear enough by good conc. to create.

Below this horizon (top unit 6), beds become rounded, mean size, thru here up bed section more bur under by long slopes & bank pits [illegible] found. Some scat shell [illegible] in lower layers, but no good [illegible] recumbents.

⑦ 4.4 Clay in clay shale in lower 1.5 with some ob to pressure sized salt layers. Upper 3.0± has more salt layers, 1 mm (under 0.2). At top is Ormsby zeolite yellow layer about 0.1 but [illegible] at [illegible] flat on beds above [illegible].

Ostracodes in float near top this unit.

⑧ 29.5 Chiefly clay shale, with obscure bedding from this, weakly scattered salt layers. Probably somewhat bentonitic. Forms gray slopes near foot of bluffs of sand (Volgate) where [illegible] to [illegible] conspicuous texture is obscured [illegible].

⑨ 0.2± Gray to dark gray mottled highly bentonic clay shale weathers to dk gray popcorn [illegible] on slopes.

⑩ 11.6 Interbedded clay shale, salt and vfg sand. Sand becoming chief constituent in salt layers. Local Festus O + [illegible] Lower bed interval salt sand layers [illegible]

Upper half thoroughly fossiliferous

(11) 5.9 — Chiefly V f g sand, with much c/o shell and interbeds of dk-gray fossil shale. In upper 2.0 crumbly gray mixture (weathered sand concretions + sand in matrix of V f g + silty (Sample with lignitic layers from top of unit) Limonite stained at top, grades fairly persistent here

(12) 20.5 — Interbedded V f g + silty sand — a gray beaded-bed unit, with interval 5.0 to 9.0 with silt sand beds up to 0.7 and more thinner + shale predominant from 9.0 - 14.0 shale with scat thin silts, then about 3.5 with numerous silts, and some wavy clayey laminae. A few scat concretions in lower thick silt zone (cotoliths thin sand)

(13) 9.0 — Sand, V f g weathers gray, loc. with OB stained sand concretions OB chips. Gross ? is Cross bedded + contorted with some clay stringers + scattered shells. Concentrated fossils in zone (base 6.0 to base. Preservation poor, some oysters — whole + shredded

To mouth along entire unit (12) changes, the silt sand interbedding is more thinner at expense of shales + it becomes difficult to separate this from sand-prone unit though it is still shallower. Here too the silt-sand bed are dominant + sand is well sorted, cross bedded, flutes. Even OB chips work down from sand unit (13 difficult to separate from (12)

Trip with Tove Birkeland, Bud Holland, Rod Feldmann and Charlie Frye - July 17, 18, 19, 20 and 21.

July 17 -

Locality 74 visit with Tove + Bud [illegible]

Collected [illegible] thin [illegible] layer above [illegible] ss
A4685 blob layer. This fauna in same position as that above "lower Colgate" sand in the badlands to N. across Moreau (Loc. 91)

Also took them to Loc. 30, and Lantry. Gave them some of "holotype tree"

July 18. Collected on Whitehorse ridge in morning, and on Grass Grass bluffs in PM - Tove and I worked together. She found Cheyenniensis with double row of nodes which I appreciated — if it is duplicated give it back to her. (Loc. 88)
Also borrowed large [illegible] glosus from Frye who found it — belongs to No. Dak. (also Loc. 88)

1st day in No. Dak (July 19)

Hump Creek – Locality 48. – Nothing new here – Izn collected some good Inoceramus. We dug out some "Holymonites" that had not yet been mineralized – the hump tubes were a gray clay.

(1) NE ¼, SW ¼, sec 10., T. 129 N., R. 81 W. a lower Hell Creek pinnacle with Fe conc layer containing gastropods & clams as steinkerns. This is just above contact lignitic shale – or assoc. with some of it

(2) SE ¼ SW ¼ sec. 26, T 134 N, R. 80 W., on south side of Cannonball River, Sioux Co., No. Dak. – East of Solen

Locality 288

A-1409

Bluffs in Fox Hills sand with conc ledges and a few scat concretions

Sphenodiscus found by Rapp. Dosiniopsis and Inoceramus in ledges – chief fossils of ledges. Mactra-like clam & wider variety, some. Discoscaphites in concretions

Note – one of best sections in area is across River, near here, cross at Solen. Boys call it Laird's section – he & Cobban measured it. Banded bed. Temlux base [illegible]

2nd Day - with Alex Cvancara

Stop

① (F-1) D2984 — About on S line Sec. 20 T133N, R88W., about 6 mi SW Lieth; So Grant Co. No. Dak. Steep cutbank on N side Cannonball.

Warm worked clayey silt with scattered small gastropods and pelecypods. Collected on Cannonball.

② (F-5) D2987 — Mid. part of ① in N facing cutbank South Side Cannonball, in SW¼, Sec. 28, T133N, R88W., about 6 mi. (airline) SW Lieth. Bluff in sandy clay-clayey sand, mixed or warm oxidized layer of 15'± between conc. layers has fossils.

③ D2980 — NW corner Sec. 21, T133N, R87W., 2 miles S. of Lieth, So Grant Co. No Dak. Pit in field in 4.5+ bed chiefly Campeloma nebrascensis; Tongue River fm.

④ D2988 — 5 miles E. of Flasher on No Dak. - Cvancara and Holland. coal locality ± 2.

(5) North Heart River SE¼ sec 10 T. 138 N, R. 83 W., about 11½ miles WSW Mandan, NE Morton Co. No Dak.

(6) D2983 4.65 mi W. RR Sta, Mandan, N Dak, on cut of US Hwy 10 - 11½ Sec 23, T. 131 N, R. 82 W.

Coral locality in Cannonball.

Saturday, July 21, Emmons Co

(1) C0432 NW¼, sec 11, T. 132 N., R. 79 W., 14 miles W of Linton, Emmons Co.,

Road cut in oyster bed with O. glabra, Corbicula, gastropod, ammonoid freq, sharks teeth, fish vertebrae. (Ammonoid frequent to Bala.

(2) D2979 The ash bed a mile or so N of Linton on "Main Street."

(3) Seeman Park. - Do not remember seeing sand there previous times. but it comes in ? or near Scrubbs comes in big red bone bearing masses. Is good Timber Lake lithology

Resume of North Dakota trip.

Told Bud of report of large shells from housing project in Bismarck. Then learned no Fox Hills in Bismarck – if these Cannonball may be ammonoids and very late Sphenos – Look into this.

Big discussion on Linton section. I argued that though no sharp change to Silty "Trail City" lithology the ls. concs + fossil accumulations were lith characters typifying T.C. and an integral part of its description (check) THIS SHOULD BE STRESSED IN REDEFINITION.

Also concurred that subunits should be on lith. basis. ∴ T.L. lith concs in top of bluff at Linton just above Gervillia concs Also – Colgate better classed as Tenuis than member locally.

Locality 94. - Bullhead Lake locality

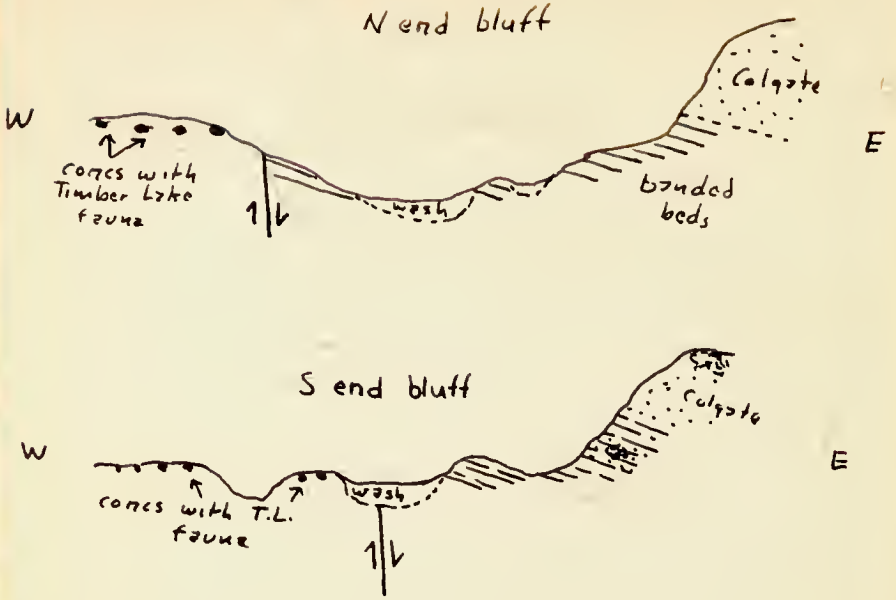
Southwest-facing bluff at E end of dam across trib. to Rock Creek, one mile N Bullhead in center E½, Sec. 13, T. 21 N., R. 24 E., Bullhead quad. So. Dak.

"Banded bed" section in upper Trail City capped by Timber Lake memb. Ian collected it and has measured section

Locality 95. - "Ridge west of Locality 2" of older collections

East-west trending ridge and spurs lying W of the Whitehorse road in S½, N½, sec. 25, T. 16 N., R. 25 E., Dewey Co., So. Dak.

The east end of this locality is on the west edge of the Whitehorse quad. sheet. The ridge extends about ½ mile + beyond and is separated from divides to N. by deep draw. Protoceratid layer rich, caps western ridge spurs + is continuously exposed along the S side. Ridge overlooks Elk Butte lowland to S. in valley of Little Moreau. Locally the D. nic layer + "Limopsis" layer are exposed along the south edge and in breaks at W. end of ridge.



Fault E of Freeman's Ranch

Bullhead - Colgate scarp

Locality 96. Freeman Ranch Fault Scarp, west facing banded bed + Colgate blvr lying east of Red Gut Creek in SE¼, sec. 4, T. 10 N., R. 19 E., Zachary Co., So. Ozk.

Scarp has two mem. sands in locale but no top to either. No known to section as fault intervenes between exposures (1 year (?) wash). T.L. fauna and broad lithology.

Section 1., taken on SW-most cliff, starts in lower part of banded bed. (N 20-30 E, 4° NE)

wash fm

① 9.0 "Banded bed" - gray silty clays and silt with relatively few silts and browns, banding not prominent, veneers to hard chalked surface on silty clays, indicate [illegible]

② 5.0 As above with slightly more distinct banding. At top are some more dark weathered zones, some OB chip layers and just above silt layer with local clot, gray to RB weathered concs scattered [illegible]

③ 12.8 Except locally this interval is a zone of mixing + contortion with scattered conc nizzes av. about 1.0 in diam. Top few feet locally shows banding but fractures may go thru entire interval plus some adjacent 0's ?

④ 4.0 Faintly banded silty clay with jarosite impregn. silt zone (persistent) at base (about 0.3'); upper 1.0-1.5 is chiefly a fissile to blocky gray shale, with jarosite impregn. silt at top (also persistent). Local concs in the top layer.

(5) 8.2 — Interbedded clayey, blocky silt, silty shale, minor clay shale and a few layers of OB stained sandy silt or VFG sand. Blocky interbedded clayey gray silts predominate. At top is thin OB stained VFG sand + silt with laminite silt assoc.

(6) 16.7 — Interbedded clayey silt, gray to dk gray shale + silty shale and scattered thin beds of silty VFG sand that are commonly weathered OB. In this interval shale layers more numerous, clayey silt layers thinner + sparcer less than 50% prob.

7. 8.0 — Sand, fg to vfg locally silty with some interbeds of gray clay shale in lower 1.5. Weathers yellowish gray and has, locally, large calc. concretionary masses, generally flattened in plane bedding but locally more spheroidal. Long diams. up to 12.0, thickness locally up to 3.0. Typical "Colgate type" graywacke.

8 17.6 — Sandy clay grading upward to clayey sand, gray, weathers yellowish gray some OB stain, has somewhat larger plant frags than most of section below.

9) 15.5 - ? — Sand, fg to vfg gray, gray wacke, local light Orange [illegible]. In upper 5-7' have brn weath conc masses holding v fm. locally coalesce to form rim rock but commonly single up to 15' across and 8' high.

Top of sand of bluff.

Laterally to north a sandstone channel comes in about in the lower half of unit 6, it also has concretions but not as large as those in other SS units. Here too the lower SS of section contains large cone in cone masses as upper one does at section of Section. In over-all highest point above bluff is about 40 to 45' above base upper SS and has cap conc SS like those below.

Locality 97, Mud Butte, small butte NE of Freemans Ranch near road. It's cap of oyster-rich sandstone has collapsed and only chunks of it remain on slopes. Cochine features oysters, high spired snails and corbiculas; also found frequent of ammonite, smaller snails and mytiloid. See collection.

A950 & A951

The caprock was Colgate, probably high Colgate. Base of in butte is the banded type siltstone between Colgate and layers in loc. 96. Slopes to E show lower banded beds and upper Timber Lake strata just coming in. To south the first large gulley heading in toward road has lower banded beds (from which P950 collected) and upper Timber Lake which is a clayey vfg sand that weathers yellowish gray at upper 10', light grey below and has rusty RB mottles and concretions near top. Farther south, just before Freemans road dips into valley of Red Cedar Creek, a bentonite is exposed S. of road not too far below the Timber Lake type cones.

No good section of T.L. and down is readily available but with proper control and plenty of sweat a composite might be put together in this area.

Locality 98 Rattlesnake Butte.

Section – Notice – measured thickness from top.

(8) 23.0–? Bulbous cap, v fg to vfg sandstone of quartzose type, silicified. Cross-bedded to x-lam; good current bedding & ripples, intensely burrowed, local undulose clay pebble cgl, and silty clay lenses, fossil wood and some fairly well preserved leaves. At several levels, cap is a sandstone but all is quartzose.

A952

unconf.

(7) 5.0 Clay, silty to sandy, in upper 5.0, blocky gray, weathers to rusty brown on surface of slope. Coal seam near top. Its strat plant fragments throughout. Bedding is horizontal gray finely silty clay shale with plant fragments, grades to lighter shale below and into about 1.5 of gray, vfg sand, x-lam above.

(6) 5.0 Clay, dark gray, plant fragments & lig streaks and partings with prominent, 1 clay, hard lignitic red-gray weathering shale at top and a tough dk gray clay at base. 1.0 to 1.5 with lig streaks & purplish cast.

(5) 3.8 Clay, tough, gray, plant fragments, silty with a few layers of laminated silt & vfg sand. At base becomes hard massive silty clay & grades to unit below.

④ 6.6 — Shaly, hard, brownish to reddish gray, lignitic, weathers to purplish gray. crumbly locally. lt vfg, local [illegible]

③ 21.0 — Sand, soft, fg to vfg, lam to [illegible] and x lam. loc. with the lt gray to OB lam. Has indurated areas and forming prominent bench on NW cor. butte slope. just under Hell Creek lig. shale. In lower 3' some carb lenses and lignitic streaks. Basal 0.2' is reworked layer of silt and clay chunks from underlying unit. Indurated area is not calcareous (see hand specimen)

② 1.5 — Clay, gray, finely silty, grading downward to sandy clay and into unit below.

① 8.0-? — Sand, vfg, lam, x lam, with layers lig brn and of gray silty clay, thruout latter rel incr. Sand becomes clayey locally.

[Note. On S. side butte huge calc. concs come into this Calgate sandy interval with tops 17' below Hell Creek contact - and base at 31' on the one measured.

Locality 75 - Revisited to collect from "marine Hell Creek"

Fossil bed is current accumulation; no valves together, much meshing indicated. Colgate beneath the lignite shale has been large concs.

Fossils are in shale about same position relative to base of Hell Creek as is the Breien member in No. Dak. The accumulation is one more common to "Colgate" in surrounding area. Note that Colgate here is somewhat atypical in being bedded & brown weathering, though similar aspect seen locally at N Iron Lightening badlands where brown-bedded Colgate grades laterally within 100 feet to typical massive, clotted light gray stuff. Angle of face may have much to do with this.

Locality 40. At southend of bluff typical Hell Creek exposure but big sands lacking. Very difficult to tie in with Loc. 75. Oyster bed at base of S end of bluff with big shale under it. High in bluff to N. is sand (pos. unit 12 below) with calcite-like concretions.

Skeleton Section.

①	3.–?	Poor surface on deep weath grey clay
②	7.0	Reddish weath in shale and clay
③	7.0	Sand, lig., with oyster beds in lense, thickest, upper one 1 ft thick is lacking O.B. cone-in-cone lower with oysters, ammonites, cerbicula etc. Lense is x long x ').
④	5.–	Sand, fine, yellow x long, weathers like grey clayey; at top white weath sand layer 0.5' with O.B. weath cone beds.
⑤	12.5	Sand as in bw (④) with clayey lig shale layers. Has fossil logs to 6" diameters upper few feet jarositic
⑥	5.8	Clay, lower 1.0 ± is liquitic crumbly ledge, above is lig grey hard clay becoming liquitic upward. 1.0 at top ± O.B. weath crumbly green Fe stained and recrystallized bones - very plentiful here.
⑦	17.5	Silty clay + clayey silt weathers to popcorn slope with scattering of Fe stained rocks weath crumbly O.B. Lower 2.0 ±

weathers gray, then about 2 feet light gray mucky fissured clayey silt, above [illegible] ? reddish gray same fissures

(8) 3.0 Liquitic shale

(9) 5.0 Shale, dk gray gray shale weathers to light gray papery

(10) 4.3 Shale as below with purple cast on weathered surface and stringers liquitic

(11) 10.5 Clayey sand w/ some pebbles - 2 inch of clayey pebbly sand bed - sandy silty at base and moves shale above 5.0

(12) 7.3 Clay sand as below at base grades upward into gray clay.

(13) 11.0 Shale, purplish gray to gray with occasional liquitic shale inclusions hard liquitic shale base. Whole interval loc. weathers purplish.

(14) 2.0+ Light gray clayey silt

Gravel exp.

Locality 91.

Section (1) NW trending spur just S NE cor. sec. 9,

Begins at flat conc. layer with cone-in-cone.

1.	0.3	Lower flat calc. concs with cone-in-cone rims, and also plain c-in-c concs. Small Idonearea in one. Below is silty clay as above for at least 15.5 feet to light gray hard only slightly clayey silt which may not be in place.
(2)	3.5'	Dk gray silty clay, weaths to grayish pepcorn, underlain by hard gray clay with lower petches silt. Jarosite in upper 1.0.
(3)	2.0	As in 3.5 but jarosite layer at base and pods jarosite thruout.
4	3.4	Covered - Flat across area of contact.
(5)	10.8	Banded beds, dominantly brownish gray shaley to clayey silt plant trays with scattered layers silt in 3 to 4 ft. top and 2 to 5 from base. At top is local, persistent layer bed weathers concs in bad silt. Only persistent such layer in this part of section (loc. vry ss)
(6)	38.0	Banded beds, chiefly shaly silts some silty shale, scattered layers of silt & vfg

sand not exceeding 0.2 in thickness. At 11.0 from base 1.0 bentonitic sh., some scatt. reddish conc., chiefly at about 12.5 and 13.5 from base.

⑦ 20.0 Brown beds, unit with thicker silts & fine ss than those below, though sand predominates. Binding marked. At base 0.4 sandy layer, others follow at —

1.2 to 1.6
5.1 to 5.4
7.8 to 8.2
10.5 to 11.5± (channels locally, also splits loc.)
13.9 to 14.2
15.5 to 15.9
18.5 to 19.0

From 16.5 - 16.9 also a silt with 0.4 on top of finely bur. silt and carb partings some chunks charcoal.

At top, upper 1.0 is light gray bentonitic clay, weathers light gray.

⑧ Sand with large concs.

Section ② — Beginning base sandstone of unit ⑧, section 1. Although details of braided beds in unit ⑦ change drastically, the base of the sand can be traced laterally without question and apparently does very little channeling.

① 20.0+ Sand, vfg, gray, clayey, loc. gray wacke, weath light gray, fluted, local white weath. conc. masses in form tabular, but also in ovoid

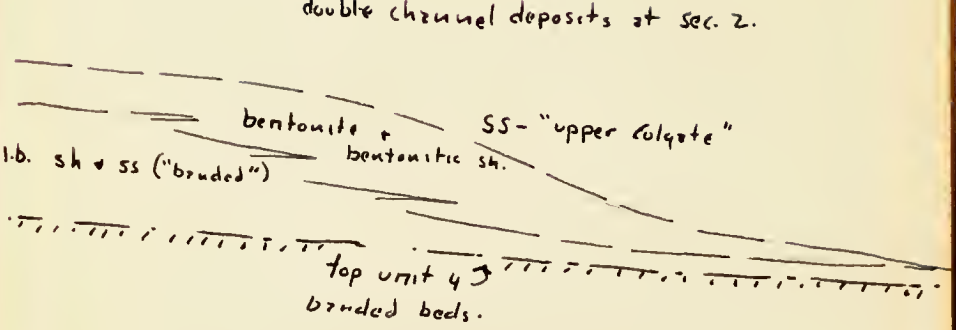
area of crop some large more
well rusty brown weath. conc
At base this unit-broader types. Part of crop weaths chestnut
fossils incl. but covers soft sand - may be
one recog. more clayey locally. Locally
clam. at top in sand are oysters, shark's
teeth etc. (Sec. Sec. 2 Coll. #1.) A796
This same sand has 0.4 to 0.6
liquitic sand just NW of A point;
here it lies about 1.0 from top

(2) (Lies on top of sand, to N65°E of A)
1.5 Bentonitic shale, weathes gray to bluish
gray papery + local sandy lenses in base
with fossils as in (1)

(3) 6.0 Broken beds, chiefly shale + silty clay
with scat thin silt beds incl.
0.2 to 0.4 at top + base. Unit
weathes olive gray in contrast to
light bluish gray of units above
below.

(4) 8.0 and silty sandy clay
Chiefly a clayey shaley silt, few
silt layers (may be vfg sand loc. Contains
small shells (oyster + small dentalium.
Silt clay finely interlam, some
few beds + lens + silt in lenses + bits.
(See spec. Sec. 2 Coll 2)
At top in. 0.8 foot is persistent bentonitic
+ bentonitic clay, sandy. weathes to
dk papery at crop, commonly
on lip of bench

(5) 4.5 - 8.0 (Bentonitic clay
recc clay. Interbedded) vfg sand + silty dk
next pkg gray shale, chiefly sand upper
2.0 where it is fine to medium
grained. Loci jarosite + OBC pts.


double channel deposits at sec. 2.
bentonite
SS - "upper Colgate"
l.b. sh + ss ("braided")
bentonitic sh.
top unit 4
braided beds.

(6) 11.5 — Bentonitic shale and claystone, sandy at base with stringers vfg sand. A local fm. cut into underlying unit and locally cut out by overlying sand. Green-gray to blue-green bentonitic shale weathers to light blue-gray deposit. This unit is maximum local thickness

(7) 25.0 ± — Sand fg, loc. soft med gr in lower part "Colgate type" grassy & locally tabular & low bedg OB chips and some compressed cones, locally with Corbicula. Locally this sand goes to fluted bedform type of colgate evap but under Δ stream it is in steep slope & cliff. & weathers brn gray with poorly developed fluting.

Note - block in float with Corbicula, [illegible] & other clams may be from this unit.

Coll #2

(8) 5.5 — Interbedded dk gray silty shale & clay wi plant frags and fg ss. Clay has silt in laminae, shaly where these or coal frags present, sand layers 0.2 to 0.5 thick decrease upward. Grades to unit (9)

(9) 17.0 — Clay, silty, gray loc dk gray a few silty layers in lower 2.0. At 6.0 purplish gray weath clay, locally lignitic. Upper 3.0 has lignitic shale leaves and some sand stringers. This unit is locally laterally in amount of carb. matter. Some Fe stone cones locally.

(10) 7.0 Sand, weathers gray white, massive fluted, some lt shale (lig shale) in lower part. Fine grained Ca petrotype

(11) 9.0 Lignitic shale and some lignite interbedded with gray shales. Fe stone small concs.

2. 17.6 Sand, v. fg and sandy clayey silt, weathers yellow gray OB stain, scat Ob concs small, local poorly indurated & lam massive. Grades to silty blocky clay in uppe. Com leaf.

(13) 2.0 – ? Lignitic clay + ironstones,

Gypsum veins under Δ station

Locality 92

Adding interval at base of Beaver Trap Cr. section
From base conc. layer at base section it is
29' to lower bentonite with conc. and conc.
between this about 5' to layers tuff altered
small [illegible] and another 30ft below this
[illegible] shale 1ft to stream bottom.
Whole under conc layer #1 is light brush
grey. is about 5' above [illegible] then goes
brownish.

Locality ~~SCE~~ 128

C355 float

Section A — Starts in Elk Butte shale at least 35 above river flat about in center of old meander scar, 35'± up on slope.

① 15.0–? Shale, dk gray, blocky to chippy, very fine silty, locally weath bon stain on fracture surfaces. Scattered rod weath Fe stone nodules in upper 4.0 and fairly persistent layer of small ones (up to 0.8 bedding thin) at top.

② 15.8 As in ① below except few silty layers begin to come in in upper 3.0. At top is CaCO3 stone conc layer of lt gray to rusty brn weath, ~~light brown to gray siderite~~. Another conc in trench 5' from top. is siderite! Fizzes in powder

③ 0.6 Dk gray silty clay (more silty than in ①)

④ 0.3 Brown stained mottled "rotole zone"; A486 SO6 samples.

⑤ 2.0 Gray clay, silty, with irreg bobs + stringers of silt. CaCO3 conc layer at top; local conc-in-conc jackets.

⑥ 6.0–? Interbedded + interlam, dk gray silty clay and light gray silt. Weaths dk ~~red~~ brown.

Slump cover

Section B. - Offsal about 75' to E

① 10.5 Conc. layer top of unit ⑤ scale, measuring up.

L 10.5 Interbedded shale, dk gy to gray silty + light gray siltstone. Silt predominate in lower 3+ feet which wea's deep rusty brn, Above silt in pods, layers + irreg blebs, but

bentonite A → laminations less well defined. Local c-wk mass about 6.5± from base.

② 16.5 Concord, creep interval uncertain of bed rest.

③ 25.0 Interbedded to interlam, grey+dk grey silty clay + light gray silt, clay, layers thicker: Upper 5' more mixed of clayey silt with jarosite blebs. Few small scat. rh. calcite concs, At top layer is rh worth concs.

④ 34.0 To base big conc. layer (1st) grs processes more silty upward becoming gray clayey silt with jarosite blebs in upper 10'± At 15.5 from base are row small is. concs.

Locality 212 (Former 561)

Section A, SW mud butte on spur, center SE¼, NW¼ sec. 26 T. 15 N. R. 21 E.

At base zone rb weath fos. cones with protoceratid & camelid bones etc., in grass. (See IGS cells

Fossil. cones mcz. coming up-

1. 38.5 Sandy clay grading to clayey sand mid weath, grey in lower slope to light brown in upper. May be some lenses in sand upward, if so it comes in about 25.0 from base

2 4.0 Clayey sand as below with layer chert & baron concs at base, locally others above it with Mactra - Tellina fauna,

3) 1.5 to m. fossils at bottom sandy beds. Coquina but appears to be a clayey sandstone

Locality 99 Maxons ranch. Spur of S-facing bluffs of Fox Hills SSW of ranch house in center E side, NW 1/4, sec. 7, T. 20 N., R. 26 E., Little Eagle quad, Corson Co., So. Dak.

Locality 100

Section A. Starting at River level - interbedded silt & clay, I-ft thick beds, whereas it should be Elk Butte. This section measured to where we are sure we're in place, and is provisional - increase LB has gone silty on us

River

① 3.0 ft — Thinly interbedded dark gray clay and light gray silt, interbedding is irregular, X lam. typical. At top is layer jacketed, flat lying concs with silt laminae and ooids into thin, weakly brn-gray jackets

② 2.3 — As in ①. At top thin (0.2) conc layer with local bigger ovoid silt-jacketed concs, weathers OB

③ 7.7 — As in ①, layer thin OB is concs at top, widely spaced.

④ 3.8 — As in ① but less silty & more dispersed in surrounding, at top OB is thin concs

⑤ 7.2 — As in ①, at top very local concs with thick silt concentric jackets.

⑥ 12.3 — As in ①, local thicker wide shale & silt up to 0.4, but also lenticular concs & thin concretions. At top good persistent layer is concs, flat-oval,

57.

limestone, dk gray, weaths br + clay

(8) 10.9 — Irreg thinly interbedded + cross-fm as below with some "worked" layers. At top is pcasil layer. Is rough weathg rusty brown. Vc + prod fossiliferous (Coll. #1) A-971

(9) 9.0 — More clayey zone with more mixed silt, otherwise as preceding. At top another layer flat ovoid, rusty weathering, 1s. concs. Some very fg sand in this int. + silt.

(9) 9.0 — Lower 3.0± clay with intermixed silt but increasingly sandy. Middle 3.0 is zone with clayey sand — sandy clay, mixed, weathg lt brownish gray on weathered surf. Upper 3.0 is mixed sandy clay with irreg sand blebs. Sand is fg-mg.

(10) 19.0 — Sandy clay and clayey sand, mixed, with sandy pockets + blebs, vert. A vuggy zone with local silt + crudely c-in-c concs at 7.0 from top and clayey sand zone with concretions heavily ferruginous zone between 11.0 and 12.0 from base.

(11) 7.5 — Sandy clay-clayey sand as above with no ferrosite stain except single rusty-yellow layer 0.7 from top. Upper 0.7 is tough clayey, gray weath sand some shale blebs at base.

(12) 0.7 B[illegible] Much concretionary.

[Of [illegible] Type [illegible] Wilcox boundary]

(13) 3.2 Sandy [illegible] diagram with gray, much thin sandy as below. At top is pervasive layer of limonite concr. Is sandy. Weathers yellowish brn with irreg. mkd surface. Locally fissile. (Coll # 2) A966, A968

(14) 23.5 Dk sandy clay in lower 8'. becoming less sandy upward & grading into gray silty clay, locally shaly. Sandy layers in lower part, a few thin at about 6.5. At top is 0.3 silty sand, pervasively [illegible] locally forms crumbly little leaves. This unit much clayier than overlying beds. (A967 just above base)

(15) 16.0 Dk gray silty to sandy, sandy clay, with scattered silt in zones at base intervals (13, 14.5, 15)

(16) 1.2 Bentonite with much concretionary.

(17) 10.0 Gray fissile sandy clay, at top is pervasive rusty zone. Lower part is concretionary with [illegible] selenite. Locally fossiliferous. Coll # 3. (A969, A970)

July 31 trip with Wayne Pettyjohn - chiefly in area cornered by Opal, Red Owl, Hyance + Mercus.
See County road map for locations

(1) Bluff overlooking valley of Sulphur Cr. from N. on road S from Opal. E side

Concretionary ledges in x lam SS overlain by soft yellow brn weath snd with dinosaur bones locally. Hard ledges have rare internal molds clams and fairly common Halymenites. Beneath snd with conc ledges is 4'-5' snd some lb sh. than scat yel. brn weath cones, lower pt. cemented snd upper ls. - much plant mash. Below this layer interbedded snd + sh, fairly thin beds, ant holes with stk + reptile teeth.

Ledge is lowest visible in Sulphur Cr. valley and l.b. shale below prob. grades down into Pierre lith. - which can be seen in trib valley at (14) Here rather silty to sndy cly has some redweath sndy ls. cones.

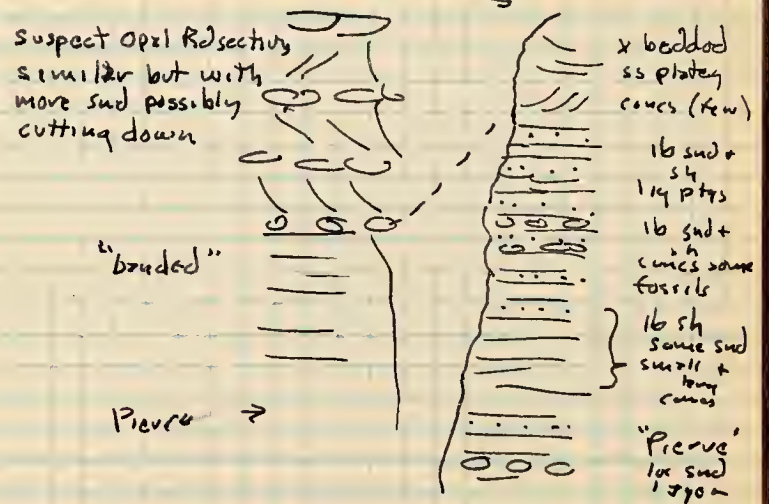
(2) Great mass of rather spectacular crossbedding chiefly in fg.ss some shale + lig layers. Conc. ledges at many different levels in this unit which seems to border valley as far east as rd S Opal. Festoon type x bedding of many small intersecting channels + a few big ones.

(3) Valley of Beaver Cr. where crossed by county road thru middle T.10N. R.14 E. Have a fine section possible from dk grey sh with jarosite buds + cones sndy ls up thru 20-30 ft lb sh + snd with scat. flat banded bed type cones to snd with some sndy lime conc layer, one of which at least - a yellow weath flat conc bed with "wormy" surface, has local fossils. Possibly the TL fauna (Pettyjohn has)

④ Similar set-up to ③ but higher, lb. snd + sh at base in creek cut gets sandier upward with sndy concs bands sh. + some liq. Petty John found Sphaeodiscus in lower part. Possibly T.L. fauna

⑤ Scattered gutter crops showing lb snd and shale, snd increasing upward, locally a few iridescent platey ammonite shell, prob. Sphaeodiscus

Impressions: Looks like good possibility of carrying known F.H. sequence in from 73 and hooking it to Opal-Red Owl area sequence. Seems only chance to 'crack' the stratigraphy. Apparently Avence-Marcus Rd sequence thus →


Suspect Opal Rd section similar but with more snd possibly cutting down
"banded"
Pierre
x bedded ss platey concs (few)
lb snd + sh liq ptgs
lb snd + sh concs some fossils
lb sh some snd small + long concs
"Pierre" lo snd typ a

Or snd layers in Rt column & thicken westward
Believe Stoneville coals over both stratigraphically and could = local liqs in beds equiv. banded beds + Colgate to E or could be basal Hell Cr.

123

Locality [redacted]. Low Buttes SSW of farmhouse in E½ NW¼, sec. 34, T. 17 N., R. 23 E., about 2.3 miles airline SSE of Firestack.

Siliceous graywacke butte cap with much "Halymenites" and scattered, rare fossils including Tancredia, ammonite frag., oysters, Pteria nebrascensis and a mactra-shaped clam. This cap mapped as Hell Cr. by Curtis. No exposures below indurated bed. Could be either upper T.L. or Colgate.

(B-1 on packages shipped)

124

Locality [redacted] Butte just NW intersection of S.D. 8 and SD 63, in

Here indurated sand in Tancredia-Halymenites biofacies with soft sand beneath locally no sign of any bedded beds.

(B-2 on packages shipped)

125

Locality [redacted] Road cuts on S.D. 63, about 1.6 miles S of junction with E. A graywacke sand with Halymenites-Tancredia assoc. and ferruginous concs with some other fossils incl. Sphenodiscus, mactra, O. patuca in clusters, Penepe, P. Inquiformis.

Local indurated masses in this sand are light gray & similar though not as hard as butte-cap sands B-1 and B-2. The fauna is identical & this is typical upper T.L. fauna

B-3 on packages shipped

B-4
#126

Small butte in center S½, sec. 31, T. 17 N., R. 24 E. On S. side the bare patches show T.L. type sand with rusty weath concs. Upward the sand becomes lighter & gradually more indurated, grading to the typical cap.
This locality and preceding views together are convincing evidence that local butte caps are indurated T.L. Fossil concs heavily incl. oysters, oysters, mactra, Helgiana, Turcicula

Not given loc. #

B-5 Outcrop T.L. with Helgmonites + Turcicula on Rt 63, roadcut N. of Five Butte in sec. 7, T 16 N, R. 24 E.

B-6 Outcrop T.L with Turcicula, Ostrea clusters, P. Inquibarmis and Helgmonites in roadcut on Rt 63 south of Five Butte in sec 18, T. 16 N., R. 24 E.

B-7
#127

Outcrop T.L. with only single float type Turcicula. Sand-stone but with big concs, locally along lower part P. Inquibarmis - oyster concs with fair Turcicula. Helgmonites locally high in crop.

Box # 18, 62 F, C, D, 56 F, A

Box # 19, 62 and 56 A, F.

Box # 20, 56 A + F

Nail Keg # 21 56, F, A, - 62 A, 92, 99

Box # 22, 92, 99, 100, 101

Box # 23, 73, 100

Box # 24, 73, 62, 100

Box # 25, No Dak fossils

Box # 26, " " "

Shipment list, summer 1962 - Freight transport

Box #1 - Locality's 82, 30 and Dog Butte

Box #2 - Loc. 30 - entire Protocardia conc. (seconds)
Miscell. from 30 and 30J.

Box #3 - Loc. 32 and 77, 35, 74

Box #4 - Loc. 50, and 60-61, 25.

Box #5 - Loc. 85, and 84, 48, 61.

Box #6 - Loc. 86, and 60, 73, 50.

Box # 7 - Loc. 56, 49, 54. and fragile 83, 56. (1 74)

Box # 8 - Loc. 88

Box # 9 - Loc. 88, 88-89, and 87-88

Box # 10 - Loc. 96, 97, 98, 91 sec. lots (+ 75 loc. and)

Box # 11 - Loc. 75 and 56E + 56A 11th samples. - Small stuff from 48, 74, w loc 2, 37 + 35.

Box # 12 - Loc. 95, and 56, 60 float, and 94

Box # 13 - Loc. 30, F, G, M, + N

Box # 14 - Loc. 60, 30L, 62A.

Box # 15 - Loc. 50, Loc 99 new Maxons

Box # 16 - Loc 62F, small 56A

Box # 17 Loc 62A, F, and 56A

Shipment list, (cont.) For transport in Div. Truck.

Box #A - Locality 30 F, L, and M. J + K.
" " 32
Ridge W. Loc. 2
Loc. 30 F. - Spec. Holotype tree

Box #B - Loc. 88, Loc. 87

Box #C - Loc. 87, Loc. 90, Loc. 83, Loc. 25,
Ridge W. Loc. 2.
(only found 90 & 87 m 1 Hwy)
(" " " 90 & 89 m 2 Wm)
(90, 89, 87, 83, 25 W AC 18 m 3 Hwy
& W Whitehouse Rd)

W
T
F
S
S
M
T

Reward if returned
to
KARL M. WAAGE
Peabody Museum
New Haven, Conn.